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A QUARTERLY ILLUSTRATED MAGAZINE DEVOTED TO ALL SUBJECTS CONNECTED WITH THE NAVIGATION OF THE AIR.

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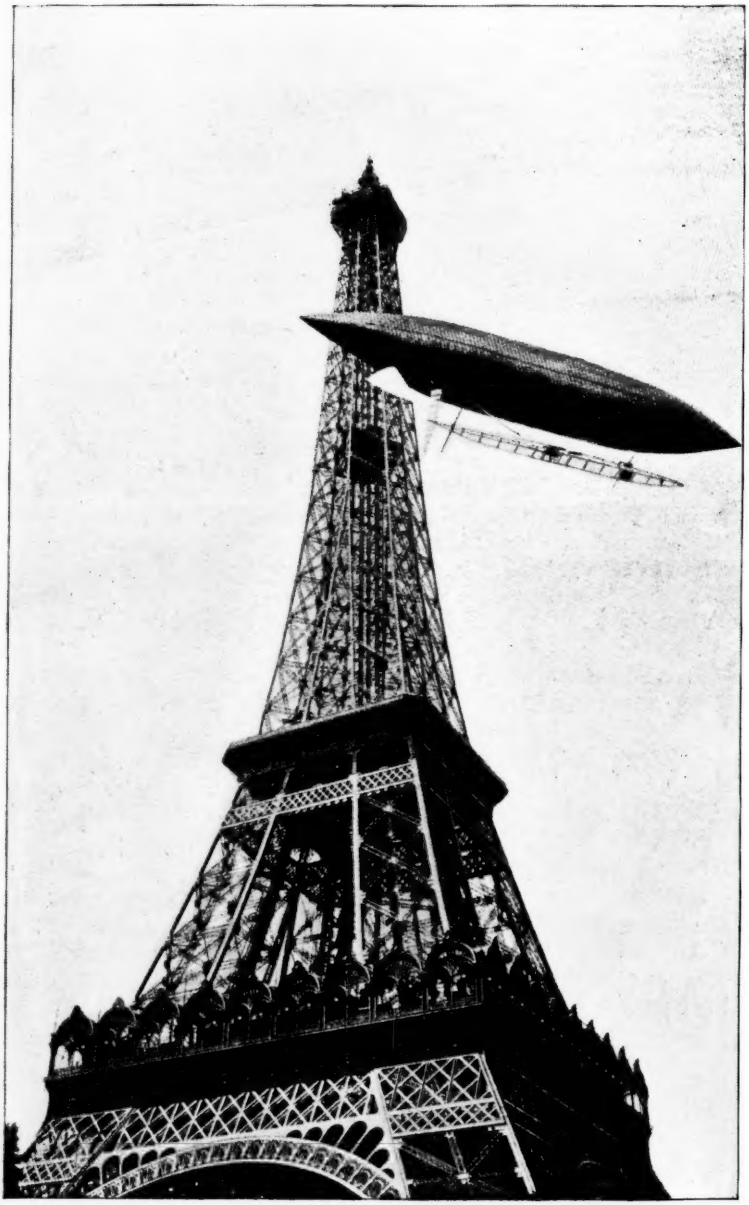

M. SANTOS DUMONT ROUNDING THE EIFFEL TOWER.

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NOTICES OF The Aëronautical Society.

At a meeting of the Council held at the Society of Arts, John Street, Adelphi, on December 3rd, 1901, the following gentlemen were elected members of the Society:—

The Hon. CHARLES STEWART ROLLS.
Mr. FREDERICK WILLIAM BISHOP.
Mr. HARRY ALAN WAGSTAFFE CAUDLER.
Mr. WILLIAM HENRY DINES.
Mr. SELWYN FRANCIS EDGE.
Mr. FREDERICK WILLIAM HUTCHINSON.
Mr. ALEXANDER OGILVIE.
Mr. HARRY JOHN SWINDLEY.

The next General Meeting of the Aëronautical Society of Great Britain will take place early in March, the exact date of which will be duly announced.

The following papers will be read:—

"The Development of Aerial Navigation in Germany," by MAJOR W. L. M. MÖEDEBECK.

"Balloon Photography," by Miss GERTRUDE BACON (with lantern Illustrations).

"Some Further Notes on the Barton Airship," by Dr. F. A. BARTON (with Exhibition of Model).

On this occasion a collection of old Prints descriptive of balloons will be exhibited by the Hon. Charles Stewart Rolls.

NOTICE TO MEMBERS.

In the event of Members of the Aëronautical Society not receiving their copy of the Journal, or Notices of Meetings, either through accidents in the post or otherwise, they are requested to immediately inform the Honorary Secretary, so that the matter may be immediately investigated.

ERIC STUART BRUCE,
Honorary Secretary.

GENERAL MEETING.

The opening meeting of the session of the Aëronautical Society was held at the Society of Arts, John Street, Adelphi, on Tuesday December 3rd, 1901. Mr. E. P. Frost, J.P., in the chair.

The CHAIRMAN: Ladies and Gentlemen,—I should like to take this opportunity of saying that while we all fully appreciate the work that our distinguished President has already done for the Society and is still doing, and also the work he has done in South Africa, we regret that he is not here to-night at this the Opening Meeting of our Session. I will now ask our Honorary Secretary to read the

Minutes of the last Meeting, after which he will be good enough to read a letter that he has received from Commander Scott, of the Antarctic Expedition, dated from sea.

The SECRETARY read the Minutes of the Meeting of July 15th, and also the following portion of a letter from Commander Scott, R.N., with reference to the use of captive observation balloons in the Antarctic Expedition.

"Our balloon, if used at all, will, I think, only be a possibility on some particularly fine day, which is likely to be of rare occurrence. My argument in its favour lay in the immense importance likely to attach to a short ascent of even a few hours. The making of an ascent will, I think, be surrounded with the greatest difficulty. But the possibilities are such that a trial is worth the making, even at the expense of the weight carried."

The CHAIRMAN: I may say now, ladies and gentlemen, that through the agency of our Honorary Secretary one of the distinguishing features of last session was the visit of the past President of the French Aeronautical Society, Mons. De Fonvielle, and his interesting and instructive paper that he read here on Balloons anl Ballooning in France. This visit I need hardly say evidenced the friendship which exists between this Society and the French Aeronautical Society. Another distinguishing feature I may mention is Col. Templer's reply to enquiries made by this Society as to the use of balloons in the South African War, and this reply of Col. Templer's, I may say, was the first intimation of the kind made to the public of the practical value of the balloons sent out to the South African War; and in using Col. Templer's own words I may say "these balloons were magnificently successful." (Cheers.) Ladies and gentlemen, were we in any other portion of the civilised globe, or I might say almost any uncivilised portion of the globe, it would hardly be necessary for me to introduce a man so distinguished and a man so well-known as Sir Hiram Maxim, and as we are all eager to hear what he has to say so far as his voice will allow—for he tells me that he has a sore throat, but I know he will do his best—as we are all eager to hear him, I will now call upon Sir Hiram Maxim to read his Paper. I might say that if there are any gentlemen who wish to ask any questions or to join in the discussion, they will be good enough to hand up their names to the Hon. Secretary. The discussion, I might remind you, must of necessity be rather short.

I.

Aerial Navigation by Bodies Heavier than the Air.

By SIR HIRAM S. MAXIM.

In preparing the short paper which I am to read here to-night, I have thought it best to point out some of the many difficulties which stand in the way of successful aerial navigation.

Shortly after the Franco-German War, the French Government decided to experiment with a view of producing a dirigeable balloon, and the work was put in the hands of Commandant Renard, who seems to have conducted his experiments in a thoroughly scientific manner. He commenced his experiments with cigar-shaped balloons, but as his experiments progressed, he ascertained that fish-shaped balloons, that is, those full forward and slim aft, required less power to drive them through the air than balloons which tapered off equally at both ends. In his experiments, Commandant Renard, has for the most part used electric motors driven by accumulators, which, unfortunately, are so heavy as to make it impossible to carry sufficient power to propel a balloon against even a light wind. It is, however, a fact that on several occasions Commandant Renard succeeded in making short excursions and returning safely to the point of departure, but this has always been done in what is known as a dead calm.

Giffard, the well-known inventor of the injector, proposed to make an elongated balloon no less than 1,000 feet in length. He was of the opinion that with this size a speed of 20 miles an hour could be obtained. But the expense and trouble of conducting such an experiment proved so great that the whole thing was abandoned.

Count Zeppelin, however, appears to have had both the pluck and the cash necessary to carry out a gigantic experiment of this kind. Still, I think it must be admitted that Count Zeppelin's experiments have not brought the solution of the question any nearer, or contributed anything to our knowledge of the subject.

As far as navigating the air with balloons is concerned, it has often been said that Commandant Renard reached the end of the tether, and accomplished all that could be accomplished in this direction. But it appears that Commandant Renard was rather chary about using petroleum motors in the

presence of a large amount of highly inflammable gas. At any rate, I am not aware that he has ever attempted to navigate the air with a balloon driven by petroleum engines. It is said that Commandant Renard had at his disposal an unlimited amount of skill and cash, but M. Santos Dumont went one better, for it would appear that he possessed not only the necessary skill and cash, but also personal pluck to a remarkable degree. M. Santos Dumont has taken advantage of the new and light petroleum motors which have been developed for the purpose of driving motor-cars, and by attaching one of these to an elongated balloon has succeeded in driving the balloon through the air at a pace considerably greater than ever has been done before. This has enabled M. Santos Dumont to make short excursions, and to return to the point of departure, even in the face of a slight wind, and this has never been done before. The work of M. Santos Dumont has been done with balloons as light and strong as it is possible to make them. He has had the advantage of the experience of the French balloon makers, who have probably reduced the balloon to as high a degree of efficiency as regards lightness and strength as it is possible to do. The motor which M. Santos Dumont employed is the lightest and strongest that modern science is capable of producing at this time. I think we may therefore conclude that as far as balloons are concerned, it will not be possible to greatly improve upon what M. Santos Dumont has already accomplished. He has advanced the science of ballooning further than it has ever gone before; in fact, I think he has come very near the boundary line, beyond which it is impossible for anyone to go.

A balloon in the very nature of things has to be very light and fragile, otherwise it would not rise in the air. Its mean density is, therefore, less than the air that it displaces, in other words, a mere bubble. If it were possible to make motors which would develop 100-horse power to every pound of weight, it would still be quite impossible to navigate a balloon, no matter how well made, against even a moderate breeze. It is not possible to make a balloon strong enough to be driven through the air at any considerable speed and at the same time light enough to rise in the air; therefore balloons must always be at the mercy of a wind no greater than that which prevails at least 300 days in the year.

Those who seek to navigate the air by machines lighter than the air, have, I think, come practically to the end of their tether. They cannot hope for any new developments which will enable them to do much better than they have already done. The possibilities before them are extremely small. On the other hand, those who seek to navigate the air with machines heavier than the air have not even made a start as yet, and the possibilities before them are very great indeed. In all Nature, we do not find a single balloon. All Nature's flying machines are heavier than the air, and depend altogether upon the development of dynamic energy. In Nature's machines the amount of energy developed for a given weight is very great indeed, but no greater than the artificial motors which we are able to produce at the present time. It is quite true that a bird can develop a great deal more energy from a pound of carbon consumed than it is possible to develop with any artificial motor, but on the other hand, Nature has not yet developed a bird that can feed on petroleum, and petroleum carries much more energy in proportion to its weight than any food on which it is possible for a bird to feed. Petroleum motors have already been developed which are sufficiently light to propel machines which fly after the manner of a bird, and we shall fly whenever we ascertain how this power may be advantageously employed. It is now only a question of time and money.

Although the difficulties which have been encountered by the balloonists in order to reduce the science to its present degree of perfection have been very great, the troubles which beset the men who would make a flying machine are still greater. The action of the air appears to be very erratic, and I propose to show some of the phenomena that one who conducts experiments with true flying machines may expect.

My first experiments were made with what might be called a "merry-go-round"—that is, I had a long arm mounted on a pivot which described a circle exactly two hundred feet in circumference. To the end of this arm I attached a cigar-shaped apparatus driven by a screw and arranged in such a manner that aeroplanes could be attached to it at any angle. This apparatus was provided with various instruments which enabled me to accurately ascertain the thrust of the screw, the power required to drive the screw, the lift of the aeroplane, and the speed in miles per hour. The first aeroplane attached was about 4 feet long, and 16 inches wide, the underneath side being slightly concave, and both the edges being made sharp, it being understood that the aeroplane was driven sidewise through the

air. I first attached it with an inclination of 1 in 14, and fastened to each of the corners strong wires so as to prevent the plane from being deformed by the lifting. Each of these wires was strong enough to stand about three times the total lift of the aeroplane. However, when the apparatus was started, and when a speed of about 45 miles an hour had been attained, it was found that the lifting effect was very uneven indeed, due probably to a light wind, and eddying currents of air. The result was that one of the wires was broken, the aeroplane destroyed, and the broken fragments destroyed the screw. After this I employed much stronger wires.

In these experiments I found that I could lift and carry at the rate of 133 pounds to the horse power, whilst I also found that it was necessary to have a speed of at least 40 miles an hour in order to produce good results.

When we fly a kite, the kite is held up against the wind by the pull of the string, and as the string is at an angle, the kite is also pulled downwards at the same time. A good kite will mount in the air until it reaches an angle where the downward pull of the string is four or five times greater than the pull against the wind. In a flying machine, the screw thrust holds the machine up against the wind or drives it through the air, which is the same thing, and the weight of the apparatus is the downward pull. Professor Langley has called the upward pull of a kite or aeroplane the lift, and the tendency of the machine to travel with the wind the drift, which, of course, is identical with the screw thrust necessary for driving a machine through the air.

With my "merry-go-round" I was able to produce fourteen times as much lift as drift, but when I made an aeroplane a foot wide, slightly concave on the underneath side, and sharp at the edges, and mounted it in a strong blast of air blown through a discharge-pipe 3 ft. square at a velocity of 42 miles an hour, I was able to obtain a lift eighteen times as great as the drift, and I think Mr. Horatio Philips, who is a very careful and clever experimenter, has also obtained a lifting effect eighteen times as great as the drift. In a true flying machine, the screw thrust must, of course, be equal to the drift, and it would be an exceedingly simple matter to make a flying machine on the aeroplane system provided we were able to produce on a large scale the same amount of lift in proportion to the drift that we are able to produce in a small experimental apparatus.

Small aeroplanes are easily made of wood, and the wood is stiff enough to prevent their being deformed by the action of the air. However, when we increase their size, we must seek something lighter than wood. In some experiments that I made with moderate-sized aeroplanes, consisting of fabric drawn tightly over a wooden frame, I found that I could only carry at the rate of 40 pounds to the horse power. Moreover, size itself is an important factor. If we should arrange a dozen aeroplanes, each a foot wide, in the air, one directly behind the other, we should find that the forward aeroplane lifted a great deal more than the one next to it, whilst the last of the series would lift very little indeed. The first aeroplane is continually striking new air, the inertia of which has not been destroyed, and in order to produce a lifting effect, it throws the air downward; consequently, all the aeroplanes which succeed this are riding on air the inertia of which has already been disturbed—in other words, the air is travelling downwards and the lifting effect becomes greatly reduced. So with large aeroplanes, the front edge practically does all the lifting, and the only way to obviate this is to make the aeroplane in the form of a curve so that the angle is always increasing, which, however, again increases the amount of power required.

In my large machine, when I ran my engines up to 360-horse power, I had a screw thrust of 2,200 pounds. If I had been able to lift even ten pounds to each pound of screw thrust, the total lifting effect of my machine would have been 22,000 pounds. But my aeroplanes were very large, and it was necessary to employ an immense number of struts, braces, and wires in order to give them the necessary rigidity, and to hold them in position, and all these offered great resistance to being driven at a high velocity through the air. The result was that with a screw thrust of 2,200 pounds, and a speed of 42 miles an hour, the lifting effect on my machine, instead of being 22,000 pounds as I had hoped, was only slightly over 10,000 pounds, and as the weight of the machine complete was 7,500 pounds, the margin of lifting effect was not very great, and even this was only obtained by the expenditure of an immense amount of power. It was originally intended by me to employ only 100-horse power, but the atmospheric resistance due to the wires and braces was so great that I ultimately mounted to 360-horse power, which required a steam pressure rather more than 300 pounds to the square inch.

I employed screw propellers 17 feet 11 inches in diameter, each with two blades. The mean thrust of each of these blades would, of course, be 550 pounds. These screws were provided with stays to prevent their being bent forward by the thrust. At first I employed wires with a margin of safety of four, but these gave way when the engines were only developing about 200-horse power, allowing the screw-blades to be bent forward, when they not only destroyed themselves, but also the greater part of the machine. Ultimately, I was obliged to employ wires, which would hold a load of at least ten times the average strain that was brought upon them, and this was due to the eddying of the wind, which put sudden and unexpected strains upon the screws. It will be remembered that my machine was mounted on a steel railway track, having a gauge of nine feet, and that there was another track having a gauge of 35 ft., outside and above this, with a reversed rail as one might say, and that the machine was mounted on springs in such a manner that the lift could be accurately measured. When, however, the lifting effect was sufficient to move the load from the steel track of nine feet gauge, another set of wheels came in contact with the inverted track which prevented the wheels from being lifted completely off the lower track.

I had at first intended to prevent the machine from being lifted off the lower track by employing cast-iron wheels of very great weight. It appeared to me that I should then be able to measure the tendency that the machine had to lift off these wheels, which would enable me to place the centre of lifting effect directly over the centre of gravity. However, when running along the track at a speed no greater than 35 miles an hour, a slight puff of wind caused the machine to lift from the track, wheels and all, and coming down, the wheels sank deep into the soft wet earth. Another slight puff of wind tipped the machine completely over, breaking the framework, and doing damage which cost at least £1,000 to repair. It was only when it was found quite impossible to keep the machine on the track at anything like a moderate pace that I was forced to provide the upper track of 35 feet gauge, and even with this it was impossible to obtain anything like accurate measurements as to lift, except in a dead calm. If the wind was blowing across the track at a velocity no greater than four miles an hour, the lift on the windward side of the machine would become excessive and dangerous, whilst the lift on the leeward side would be correspondingly diminished.

In one of my last experiments, I tied the machine up to a dynamometer, and ran up the steam pressure until the screw thrust exceeded 2,200 pounds, and then when the engines and everything were developing this tremendous amount of power, the machine was suddenly detached from the dynamometer, and darted forward with a suddenness for which the crew of four men were not quite prepared, for every man who was not holding on to something with his hands was thrown down. We soon obtained a speed of 42 miles an hour, when all the wheels were seen to be running on the upper track, and revolving in the opposite direction from those on the lower track. After running about 1,000 feet, one of the axletrees for holding the machine down doubled up. This put the whole lift of the machine on to the other three. The upper track was broken, the machine was liberated and floated in the air, giving those on board the sensation of being in a boat. However, a piece of the broken track caught in one of the screws; at the same instant I shut off the steam, and the machine stopped and settled to the ground, the wheels sinking into the soft turf, without leaving any other marks, showing that the machine came directly down, and did not run on the grass before coming to a stop.

In making these experiments, the wheels that engaged the upper track did not come in contact until the machine had lifted about six inches. The first five inches of lift were employed for working the pencil on two dynagraphs, which furnished a diagram of the lift through the entire length of the road. At the end of the five inches, however, the machine had to lift completely off the lower wheels. By this means, not only did we have a diagram showing the exact lift off both the forward and back axletrees, but by painting the wheels before starting we could easily ascertain at what point the machine was actually lifted from the lower track, and came in contact with the upper track.

These experiments demonstrated that a machine could be made on a large scale in which the lifting effect was considerably greater than the weight of the machine. At that time, the steam engine appeared to be most suitable for the purpose, but since that time, great improvements have been made in the direction of extreme lightness in petroleum motors, and I am strongly of the opinion at the present moment that very much better re-

sults could be obtained with petroleum motors than I obtained with a steam engine. Moreover, the quantity of water required is about seven times as great with a steam engine as that required to cool the cylinders of a petroleum motor of the same power.

In my first experiments I had provided a very light condenser, which on account of being driven through the air at a high velocity was very efficient, so that the weight of metal was only one pound for the water condensed from each horse power. I was able to condense all my steam when the power did not exceed 100-horse power, but it was quite out of the question with 360-horse-power; consequently, my water-supply would only last for a few minutes.

Not only have great improvements been made in motors, during the last ten years, but aluminium has been greatly improved. I have seen specimens of aluminium hardened with from 20 per cent. to 30 per cent. of magnesium which are quite as light as pure aluminium, and yet have the strength and stiffness of wrought-iron. This puts into the hands of the engineer a light and reliable material infinitely better than anything that could be obtained at the time I conducted my experiments.

My experiments were made at Baldwyn's Park, but the amount of room at my disposal was insufficient, as I found a great deal of manœuvring would be necessary before I should be able to cast off and launch the machine into free air. The art of managing a flying machine in the air without practice is like attempting to learn to ride a bicycle without a bicycle or learning to skate without skates. It is difficult to learn the art of flying without actual practice in the air, and the actual management of a machine in the air, no matter how perfect, will require quite as much skill as is required to ride a bicycle, as well as the nerve and the pluck of a Santos Dumont. I think it will therefore be obvious that those who would navigate the air with machines heavier than the air have a task before them which is worthy of their steel. However, we have the motive power and the material at hand, and with skill, pluck, and plenty of cash, as well as room for manœuvring close to the ground, actual flight on true flying machines is not only possible, but practicable, and when such a machine makes its appearance, although it may not be profitably employed for carrying passengers or freight, it will yet be of inestimable value to the Empire for military purposes.

MR. PERCIVAL SPENCER: I think, possibly, we shall all agree that the one important point that has been given to the world to-night is that Sir Hiram Maxim considers the steam engine that he used is very much superseded at the present time by the ordinary motor car oil engines, so that having this extra means at our command we have an extra assurance of navigating the air by means of the aeroplane.

MR. E. HUMPHREY WINGFIELD: I was exceedingly interested in this subject which was rather foreign to my own experience. There was one remark Sir Hiram made, if I understood him correctly, that the friction of the surface air was practically nil. At the sister institution, the Civil Engineers, there is a discussion going on to-night on the resistance due to the air experienced on railways, and my own impression is that the friction on the side is comparatively unimportant; it is chiefly the end of the train. This bears rather on the same subject, and I should be glad if Sir Hiram would tell me if I understood him correctly in saying that the surface friction was really negligable.

SIR HIRAM MAXIM: Mr. Chairman, Ladies and Gentlemen,—In regard to the wind, there are very few people who get a proper grasp of the conditions of wind, that is when they have left the surface of the earth. No matter what velocity of the wind may be blowing, the fleeciest cloud is not torn asunder provided it is far enough from the earth. The rolling and the tumbling effect and the ebbing is produced when the clouds are passing over mountains and trees. Professor Langley has conducted a series of experiments in Washington to show that the movement of the air, the irregular lifting and the ebbing, is due altogether to the unevenness of the surface of the earth over which it passes, just exactly as when we see a large stream of water flowing over boulders, we can tell where the boulders are by the motion of the water. But there is one thing that we should always take into consideration, and that is although the air may appear perfectly stationary to a balloon, if we throw a feather or a piece of gold leaf overboard it keeps along with it notwithstanding the fact that the wind might be blowing at the rate of 50 miles an hour. We might say that we are in the wind, that is the ocean we are in, and so far as we are concerned the earth is travelling through the air like ourselves in the balloon or in the flying machine. Suppose the wind was blowing at the rate of 40 miles an hour, if we wish to keep over the

same spot we should have to travel through the air 40 miles an hour. Again, if we were travelling 40 miles and we were travelling in the other direction, we might go 60 miles an hour. That is one of the conditions we find in the air, and it is the condition that one must meet if one travels through the air. We must always consider that the air is moving as related to the earth. We do not wish to go to some point in the air, we wish to leave one part of the earth and go to another; and if we find the air is going at the rate of 20 miles an hour we are not able to go unless we are going in the same direction as the wind. That has been the trouble with all sorts of balloons for navigating the air. When I was in France one of the experimenters told me that the speed of their balloons was always just a little less than the speed of the air, the result was they always went along with the wind whether they wanted to or not. Suppose now, gentlemen, that we should make the strongest balloon that was possible and used the strongest Japan silk, and used the lightest varnish and charged it with hydrogen gas and made it as strong as we could, and suppose then, we should attach it to a locomotive, when the locomotive was moving slowly along it would follow the locomotive, when we reached 15 miles an hour the front of the balloon would become deformed, a pocket would be formed, and the instant it was formed it would tear it to pieces. It is impossible to form anything that will stand the air equal to the velocity that one finds at least 300 days in the year. Now with regard to the matter of friction, my experiments proved that so far as moving bodies were concerned, atmospheric skin friction might be considered not to exist at all, it was a quantity so infinitely small that it might be neglected altogether.

The CHAIRMAN: I now call upon Mr. William Marriott to read his paper on Atmospheric Currents.

II.

Atmospheric Currents.

By WILLIAM MARRIOTT.

MR. WILLIAM MARRIOTT: Mr. Chairman, when your Secretary asked me some months ago if I would come here some evening and speak at the Meeting of the Aëronautical Society on the subject of air currents or something of the kind, I was unable to do so at the time. But once again he came to me and I foolishly said "yes," and since I have had notice of this Meeting I have been regretting that I did say yes, because I am afraid whatever little I should have to say would be of a very elementary character and would not be of much service after all. However, I propose to show you some slides to-night and to treat the subject more from a meteorological, than an aëronautical point of view, and if you will bear with me for a little introduction leading up to the upper air we may, perhaps, be able to pass a few minutes' time together.

The remarks which follow refer to the slides shown to the Meeting, which, for obvious reasons, cannot be reproduced herewith.

We will assume that we are treating the subject from a meteorological point of view, and, therefore, we will start as a meteorological observer. First of all we have a representative meteorological station, which is an inclosure containing thermometers, raingauge, anemometer and various instruments for recording the temperature of the air, the amount of rainfall, the force and velocity of the wind, etc. The Stevenson screen contains four thermometers, one showing the highest temperature, one the lowest, the third shows the temperature of the air at the time, and the fourth, by the side, is to show the amount of moisture in the air. But we are not dealing with that subject to-night; we propose to deal rather with pressure, and that means that we use a barometer, two patterns of which are shown here, the Fortin standard barometer, with an adjustable cistern and the Kew pattern barometer with a closed cistern. By this means we can ascertain the pressure of the atmosphere at a given place.

That is a view of the Royal Observatory; it shows the anemometers for recording the pressure and velocity of the wind. These observations have been carried on for many years. This is the Osler pressure anemometer; it has a vane with a pressure plate kept face to the wind, and it continuously records on the table below both the direction and the pressure of the wind. As is shown in this diagram it gives the direction of the wind for 24 hours right through the day. Here the wind has been S.S.E., then it changed to S.S.W., and then, subsequently, to S.W. The pressure is given here in lbs. per square foot. This was the day of the gale, December 29th and 30th, 1899. For recording the velocity of the wind an anemometer called Robinson's is used. The cups were supposed to revolve at

one-third of the velocity of the wind, and the dials have been graduated on that assumption; but of recent years that factor has been found to be too great and the coefficient should be about 2.2 instead of 3.

This slide shows the record taken at the Royal Observatory, Greenwich, with a similar instrument on the same day. Nearly 800 miles were recorded during the 24 hours at the Royal Observatory on this day. Well, where we have not a recording instrument we have to estimate the force of the wind on what is called Beaufort's Scale. This was a scale devised by Admiral Sir Francis Beaufort for sailing-ships in the Navy; but sailing-ships have gone out of date altogether, still the scale is used at the present time and we have the equivalent velocities per hour against each half of the scale. This (referring to diagram), gives the velocities to the old factor 3, and this to the revised factor 2.2.

Having got our observations we may treat them in two different ways. The old plan used to be to collect observations, make them day after day and year after year, and sum them up and take the average or the mean for as long a period as possible. If we do this we get the climatic features of a place, and by comparing the climatic features of one place with another we are able to determine what the characteristics are of any parts of the country or all over the world. That is called "climate." In contradistinction to that we have "weather," which is the weather existing at the same instant of time over a large part of the country. We compare it at 9 o'clock, and at the same hour it is taken at Falmouth, or Edinburgh, or any other part. But the first, "climate," is arrived at by taking the average over a long period of observations. Taking the direction of the wind at the Royal Observatory, Greenwich, for something like 40 years we find S.W. is the prevailing wind with 106 days out of the 365, whereas there are 41 W., 40 N., 42 N.E., and so on.

Now if we put our observations on a map, supposing these figures represented the various places and this was an observation at, say London, this Liverpool, and so on, they do not show us very much, but if we draw a line and join certain parts which have the same figures as shown here, we find that we get certain areas enclosed by continuous lines. If we do that, we can dispense with the figures and use the lines only and get a figure something like this. Now if we use this figure or these lines they will serve either for temperature or pressure. If we use them for temperature we call them "isothermals," or lines of equal temperature; or for pressure we call them "isobars." By adopting such a plan we can draw maps of anything we like. For instance, here is a temperature map of the globe for the month of January. The barometric pressure is dependent very largely upon the question of temperature, but I am not going into that to-night. This shows over the northern hemisphere that the temperature is cold, whereas in the southern it is warm; but here we get extremely cold, especially in Siberia. In July, the conditions are different; we have very little cold comparatively, it is confined mostly to the southern regions, and it is much warmer over the Continents.

Now, if we take a map of the atmospheric pressure, with which we have more to deal, we have for January high pressure in the northern hemisphere over the Continents, and the highest pressure of all in the interior, where we saw that intensly cold patch just now; whilst over the North Atlantic we get a lower pressure; and in the southern hemisphere we get a comparatively low pressure over the land. I want you also to notice on this map that the direction of the wind is shown by these arrows; you will also notice that there is a relation between these arrows and the direction of the isobars. Mostly the arrows run very nearly parallel with the isobars, but we shall have to speak about that a little more presently. You will find with the high pressure there is a tendency for the arrows to come outward, whereas with the low there is a tendency for them to come somewhat inward. Taking the map for July we find a contrast; we had the high pressure in the northern hemisphere in January, whereas we get it in the south in July, and we get the lower pressure over the Continents because as I said there was a connection between the temperature and the pressure. A Dutch meteorologist (Buys Ballot) some years ago went into the question of the relative direction of the wind to the isobars, and he propounded this law: "Stand with your back to the wind and the barometer will be lower on your left hand than on your right." This is a fundamental principle. Now we will try and apply that to some of the charts that we shall view.

Here is a specimen of a weather chart published by the Meteorological Office, where we have North-West Europe with the low pressure, or the barometer is lowest, in this district, and highest down here. (Indicating.) There is a considerable difference, and it shows there is an inch and a half difference between those two parts; the wind consequently is rather strong, and it blows, as you see, very nearly parallel with these lines, but here it has a tendency to blow inwards into the centre of the low pressure, whereas it blows outwards from the centre of the high pressure. The closer these isobars are together the stronger is the wind.

Now take a different type. Here we have the wind not so strong; the isobars are farther apart. I may tell you the nomenclature for this high and low pressure system—for the low "cyclonic" or "cyclones," and for the higher pressure "anticyclones" because it is assumed that the weather conditions are practically opposite the one to the other. As I have already said, round the low pressure the wind blows this way, that is in the opposite direction to the way the hands of a watch go, whereas with the high pressure it goes round with the hands of the watch, and the weather conditions are thus practically opposite the one to the other.

Now here I want to point out that we have high pressure there, while we have here a wedge or ridge of high pressure, another pressure here and a low pressure going out there. (Indicating.) When it occurs somewhere about here there is usually a calm, the wind is blowing that way, and it is influenced by that low pressure, whereas this wind is influenced by the incoming low pressure. Cyclonic systems have a tendency to travel usually in a N.E. direction.

Here is another chart showing high pressure over Scandinavia and also over the South-West of Ireland, whereas low pressure is down here and we get over England and Wales northerly to north-easterly winds. Under such circumstances the wind is particularly keen and very dry.

Now here is another type. I do not know—I have not been up in a balloon and I have not had anything to do with ballooning—but I daresay it is very desirable to know what direction the balloon is likely to take, and sometimes it is a difficult matter to see where it will go. If you have such a type as this, supposing you were here and you had a south-westerly wind you would think you were going in a north-easterly direction. Well, after a time with a little disturbance like this you would find when you got up some distance that you were influenced by some other current. You see here there is a general low pressure, but there has been some little depression or subsidiary disturbance which affects the whole of this district, and this usually brings bad weather and throws one out in one's assumption of what the coming weather is likely to be.

Here we have certain types set forth; these are largely hypothetical. High pressure shows here with the wind circulating round in the direction of the hands of a watch but blowing outwards, and in this usually the air is quiescent or calm and the wind comparatively light. On the outskirts of that there are usually depressions or cyclones passing along round it, but usually taking this direction. Here, we have a well-marked depression, and here is another, and here another; but you will notice that in between there are eddies which indicate the ridges of high pressure, and in here we get bright weather, but next morning we get wind or bad weather due to the on-coming depression, and then we have a cyclone brought in which upsets the calculations of those who forecast the weather. Between two high pressures there is a V-shaped depression, and that brings variable weather, sometimes such weather as upset Her Majesty's ship *Eurydice* off the Isle of Wight some years ago.

Now, we have been dealing with what takes place upon the surface of the earth, and our instruments will only show us that. We can only get our information as to what goes on above at present from the motion and forms of the clouds. The study of clouds has been taken up for very many years past. Luke Howard was one of the first who devoted attention to it systematically, and it is now carried on especially all over the Continent of Europe and other parts by people who are observing the forms of clouds, their rates of velocity, and also their altitude.

Here is a picture showing the various forms of clouds with the names given. The lowest is stratus, then nimbus, cumulo-stratus, cumulus, strato-cumulus, alto-stratus, alto-cumulus, cirro-cumulus, cirro-stratus, and cirrus. The difficulty under which meteorologists work is that there may be a fog and so we cannot see the sky, and we can only do so by going up mountains or in balloons. But we wish to ascertain the currents of the air, and we trust the members of the Aëronautical

Society will be able to help us somewhat in this matter.

Now just to show a few more specimens of clouds we will pass these slides very hurriedly through. I will not attempt to describe them because the time is passing on. That is a cumulus cloud. It was taken by the Hon. Ralph Abercromby, and the next two or three were also taken by him. Mr. Abercromby devoted a very great deal of attention to the forms of clouds and also to their altitude. He conversed with a good many meteorologists in various parts of the world and helped to devise that nomenclature which we saw on the screen just now.

Now we get to some higher clouds. That is the cirro-cumulus, and we shall soon get up to cirrus, the highest of all. That particular one was taken in Sydney, New South Wales, by Mr. Russell, the Government astronomer.

Here is Cirrus, or the highest of the clouds. Clouds have been seen by balloonists at all altitudes, even the highest to which they have gone.

This is a portrait of Mr. Glaisher, who made the highest balloon ascent on record. He was my old master, and devoted a very great deal of attention to this subject. He found in his balloon ascents that as a rule they went faster than the anemometers showed the record of the wind below. And at times they went in various directions; sometimes they had three or four different currents, and, fortunately for him, he came down in safety on each occasion. Now, recently, observations have been made, or attempted to be made, with kites, especially by Mr. Rotch, of the Blue Hill Observatory. Mr. Rotch has read two or three papers before the Royal Meteorological Society, and I am permitted to show some of the photos which he sent over to illustrate his paper.

This shows the method of kite-flying. This is the Hargreave or box kite, and this Mr. Clayton's keel kite; they had three or four kites to help each other, and suspended from them was an apparatus for showing the temperature and humidity of the atmosphere.

This is the Hargreave kite. This shows the method of raising the kite, and by such means they were able to obtain a record something like that shown on the screen. This was taken October 8th, 1896; it gives the barometric pressure showing that they went to an altitude of about 8,000 ft. Here is the record of the humidity; and this shows the temperature. Mr. Rotch has recently propounded a scheme for flying kites at sea. We have a difficulty in getting observations or of knowing anything of what was going on in the atmosphere over the sea. He proposes that kites should be flown on a steamship, and he has practically demonstrated the feasibility of this on two occasions.

This is the first, in Massachusetts Bay in August last; here is the windlass and here is Mr. Rotch himself. From that he went on to flying kites as he came across the Atlantic from Boston to Liverpool in the steamer, *The Commonwealth*. While out at sea he obtained records on three days, particulars of which are given here. This shows the temperature on board the ship; this the one up above, and so on for the three days. This gives the record of the barometer for the three days, showing that on this occasion the height was higher on the last day. This shows the relative humidity on board ship and also up in the air; whilst the top line shows the velocity of the wind. We have heard to-night about the balloons floating with the wind, and that is the great difficulty with regard to meteorological observations in balloons, because the balloons float along with the wind. We want to know what goes on there. There is no circulation around the thermometers, nor do we get any wind record on the anemometer. But with kites we get both the direction and the velocity of the wind. If the Aëronautical Society can help the Royal Meteorological Society in obtaining information on the subject of the upper air we shall be delighted.

MR. PERCIVAL SPENCER: I think I might say with regard to the Beaufort Notation as given there, there is one very peculiar effect. The greatest wind used to be recorded as 100 miles an hour; I notice it is 77 miles an hour. I was at Wincanton, in Somerset, and in an hour and a half we descended in Norfolk 180 miles away—from half-past three to five o'clock. The balloon had actually been travelling at 120 miles an hour. That scarcely agrees with this maximum of 77 miles an hour.

MR. MARRIOTT: I think I stated that we deal with anemometers on the ground. The balloon is carried a considerable distance above the earth, and Sir Hiram Maxim has also stated that it is the buildings and the contour in the country which affect the currents of air. Your balloon was above this probably, and there was no resistance.

The CHAIRMAN: In passing on to the next paper, ladies and gentlemen, I may say that, together with the Aero Club of the United Kingdom, which has recently entertained at a banquet the intrepid and brilliant aeronaut with Lord Dundonald in the chair, we, of the British nation, admire and do honour to any man, of whatever nationality, who, at the risk of his life, achieves victory over natural obstacles. M. Santos Dumont has done this, and we hope that the achievement that he has already accomplished in making the balloon somewhat steerable will lead on to greater achievements. I will now call upon Mr. Bruce to speak on M. Santos Dumont's experiments.

III.

The Scientific Aspects of M. Santos Dumont's Experiments.

(*Frontispiece.*)

Mr. E. S. BRUCE: My first feelings on rising to speak to you of M. Santos Dumont's experiments are those of regret that the President of our Society is not here this evening to undertake this task, for I cannot help picturing to myself how consummately he would have addressed you, and the mental image I have before me of his earnestness when discoursing on an aerial topic seems to deaden my own efforts. But I will ask you to patiently hear a few words from me as his substitute. I think all present will agree with me that it is the duty of every scientific society when examining the details of any new experiment that falls within its scope to search diligently for the truth; and, therefore, it would seem to be the duty of the oldest Aeronautical Society in the world to examine carefully the conditions under which the experiments of M. Santos Dumont were made, in the endeavour to ascertain what truths they teach. Not that I think that the whole truth can be discerned in one meeting. There is an old saying of Tacitus that truth is brought to light by time and reflection, not by haste. I will, however, bring before you a few scientific facts and make a few suggestions that may help our effort to discover how exactly the experiments of M. Santos Dumont form a landmark in the history of aerial navigation.

It may, perhaps, throw light upon the question if we look back upon the past history of navigable balloons. M. Giffard was the first to devise a navigable balloon. He discarded the ordinary spherical shape of the balloon and adopted an elongated form pointed at both ends. He employed steam for the motive power, making a light engine and boiler as shown in the picture. The engine worked a screw 12 feet in diameter. Behind the screw there was a rudder, a kind of triangular sail. You will notice that the chimney of the boiler is inverted so as to minimize the danger of the gas in the balloon becoming ignited. M. Giffard ascended in his balloon on the 24th September, 1852. There was a strong wind blowing at the time, and he never attempted to struggle directly against it, but only made circular movements and lateral elevations. I have often wondered why, after these elaborate preparations no future experiment was made. M. De Fonvielle, who was an intimate friend of M. Giffard, told me the other day that the real reason was that M. Giffard was dissatisfied with the boiler he had evolved, and on account of the boiler gave up the experiments.

The brothers Tissandier, in 1883, devised a balloon of somewhat similar form in which the motive-power was electricity, and it is stated that with this balloon they held their own against a wind of nearly three metres a second.

The experiments of Capts. Krebs and Renard in 1885 were noteworthy as being the first in which a direct return journey was made to the spot whence the balloon started. Before you, on the screen, is a picture of the balloon, "La France" pursuing its aerial way above the Pont du Jour, Paris. This is the facsimile of an instantaneous photograph executed at the Observatory of Physical Astronomy at Meudon. You notice the bird or fish shape of the balloon. The screw was worked by means of an electric motor fed by a bichromate battery of special construction. In the accounts Capt. Renard sent in to the French Academy, it is said that out of seven journeys this balloon returned five times to the place from which it started. The map on the screen shows you a series of three journeys. This dotted line represents the journey of the 25th August, 1885. This journey, as you see by the abrupt cessation of the dotted line, was abortive. The balloon started from Meudon and was unable to make a return journey. The second dotted line represents the ascent of the 22nd September, 1885, in which a return journey was actually performed. On this day the wind blew from the north north-east from Paris at a velocity of from 3 to 3.50 metres per second. Start-

ing from Meudon, the balloon was directed towards Paris at 4.25 p.m. It crossed the railway line at 4.55 p.m., reached the Seine at 5 o'clock. At 5.12 the balloon entered the enceincte by the bastion 65. Then the aeronauts decided to go home. The balloon was easily turned, and aided now by the aerial current reached the exact spot whence it had started. The part of the journey against the wind took 47 minutes, the part with the wind 11 minutes. On the day following a very similar journey was performed as shown by the thick line in the diagram. Thus Capts. Krebs and Renard in 1885 succeeded in steering a balloon, making return journeys in such very light winds as amounted to calm weather. Possibly the question may occur to some whether, if in 1885 there had been a prize offered for a navigable balloon that would go from a certain point, round a certain point, and back to a certain point in a certain time, it might not have been won by the balloon "La France." In principle there is nothing against such a supposition. I would, however, suggest that the bichromate electric battery used for the purpose of working the electric motor would have been a very unsatisfactory method of obtaining power for the screw, for any lengthy series of experiments.

Next we come to the experiments of Count Zeppelin with his enormous airship, 420 feet long and worked by means of two Daimler petroleum motors of 16-horse power, several pictures of which were exhibited at the meeting of this Society in April last. The most novel feature of this undertaking was the aluminium framework, which contained 17 distinct balloons, thus affording protection from a sudden collapse of the whole structure. The best journey from a scientific point of view undertaken by this airship was on October 21st, when a short return journey was made, the airship being up 20 minutes only. But it does not appear that the airship encountered a greater windforce than that experienced by Capts. Krebs and Renard, being about three metres a second.

The next series of experiments are those of M. Santos Dumont. I have no hesitation in saying that we are now considering the work of a very remarkable man, and this much can certainly be said, that he is the first aeronaut in the history of aerial navigation who has steered a balloon from a given point, round a given point, and back up to time. Thus if he has not advanced aeronautics in principle he has undoubtedly in practice. There is also much to admire in the personal qualities of M. Santos Dumont. What qualities are dearer to the British heart than pluck, courage, and dogged determination to attain the object sought? All these qualities have been vigorously displayed in M. Santos Dumont's work. To him temporary failures which would have crushed and defeated less manly spirits have been merely instructive stages of airship construction. The work of M. Santos Dumont, too, has shown an exceptional originality of detail. For instance, the introduction of the ballonet, or inner balloon, to maintain the rigidity of the outer envelope, seems an inspiration. By a most simple experiment I can demonstrate to you the action of this ballonet. Here is a small goldbeaters' skin balloon. In the inside of this there is a much smaller one. The outer balloon has lost its rigidity, it is, in fact, *quite flabby*. But I blow air inside the inner balloon and you can see the outer balloon extending until it is as light as a drum. Now it is most important for a navigable balloon that it should keep its shape rigidly, if it is to combat any wind. M. Santos Dumont pumps air into the inner balloon by means of a fan to keep the envelope rigid when it gets flabby by loss of gas. The importance of the ballonet was proved by the accident of August 8th. On this occasion the ballonet apparatus did not work properly, and the balloon lost its rigidity and got entangled in the machinery, with the result that M. Santos Dumont had to precipitate himself on to the roof of the Troccadero Hotel.

To further exemplify the importance of the rigidity of the envelope of a navigable balloon I will show you a simple experiment.

1. On this balloon, which is fully and rigidly inflated, I drop a heavy weight. It bounds off the balloon leaving the delicate structure undamaged.

2. On this second balloon, which is flabby, I drop a weight and the balloon bursts.

I might mention various other ingenious details of M. Santos Dumont's mechanism and accessories. Such as the abolition of the time-honoured net, and the fastening of the framework which supports car and apparatus to the balloon by rigid steel wires.

But the main point in a navigable balloon experiment is the wind force overcome. How has M. Santos Dumont made any advance over his predecessors in this important respect? I was very anxious to throw some light on this point by figures, so I took advantage of our friendly relations with La Société Française de Navigation Aerienne, and wrote

specially to enquire the wind force on the day M. Santos Dumont won the Deutsch prize. With that courtesy and consideration that invariably shown by the Société Française de Navigation Aerienne to our Society, I had a prompt reply. In fact, M. De Fonvielle, the late President of the French Society paid a special visit for us to the Eiffel Tower where registering anemometers are kept day and night in operation at an altitude of 305 metres from the ground, and he found that at 2.42 p.m., when the balloon started from the grounds of the Aero-Club, the wind had a force of 4½ metres per second. Eleven minutes later when the balloon rounded the Eiffel Tower it had increased in force and was about 5 metres per second. Now I think these figures prove that M. Santos Dumont has made an advance as regards the wind force overcome though it is a small one, about a metre and a half a second over the wind encountered by Captains Krebs and Renard in 1885. In these experiments the due measurement of the wind force is of the utmost importance, and measurements should undoubtedly be made on the airship itself, though there are difficulties in taking anemometer measurements on a moving body. As far as I can ascertain M. Santos Dumont did not have a registering apparatus on the airship on the day on which he won the prize. M. De Fonvielle states that the Société Française de Navigation Aerienne are about to undertake navigable balloon competitions, and that a condition imposed upon competitors is that every competitor must take a registering anemometer on his airship. I should like to throw out a further suggestion, that in any future competitions for a prize the wind force should be a condition of the competition, and that the competitors should no longer be free to select their own days, which, in the past, have been calm ones or those of very light winds.

It is now proved that a balloon can be navigated in a very light wind; but we must go further and test by experiment whether, as Sir Hiram Maxim thinks, the limit has been reached. This may seem a cruel suggestion, for if the limit has been reached, in such a competition the balloon will burst when forced against a wind of even breezy proportions. I do not want to dogmatise, for the duty of a secretary is rather always to hold the scales, to be ever weighing for others to draw conclusions; but I will say this much, that in such a competition I should advise the competitors to be provided with parachutes, and not only to be provided with them but to be thoroughly practised in their use, for they may have to leave their balloons in floating fragments behind them. It will be urged that it would be difficult to fix a definite wind force. Where is the wind force to be fixed, near the ground or 300 feet high, at the beginning, middle or end of the competition? I do not under-estimate the difficulties in the way of fixing such a wind force limit, and it is a matter requiring much consideration and discussion.

A series of lantern illustrations descriptive of M. Santos Dumont's experiments were then shown on the screen.

In concluding these remarks on the experiments of M. Santos Dumont I would exhort all those who are at work on the grand problem of the mastery of the air to take to heart one lesson taught by the efforts of the bold Brazilian aeronaut, that is, never to mind failures, and whenever you fail look to the cause. When you have found that you have probably found the road to success, and, like M. Santos Dumont has done, work with enthusiasm, for that is the life-blood of science, as it is of art—in other words it is earnestness of purpose. And when, in the twilight of our imperfect knowledge, you appear at times to meet with insuperable obstacles—then apply to your own special work the inspiring words of a living author who is present with us to-night.

"There are realms of knowledge awaiting the human race, kingships waiting kings, children of earth will ye not rise up and fill these thrones and wear these golden crowns?"

The CHAIRMAN: Were I commenting adequately on the interesting papers we have heard this evening I should feel very sorry indeed for my hearers, for we should not get home till morning I am sure. But the study of aerial navigation by bodies heavier than the air is a study I am particularly interested in; therefore, to me, at any rate, the paper was interesting. Mr. Marriott's remarks were truly interesting and instructive, and they must have been highly appreciated by many, and I am quite sure, ladies and gentlemen, you will be with me in thanking Sir Hiram Maxim, Mr. Marriott and Mr. Eric Stuart Bruce, one and all, for their most interesting papers. With these few words I beg to thank you for your kind attendance and attention here to-night.

A vote of thanks to the Chairman terminated the proceedings.

The War Balloon in South Africa.

By Major B. Baden-Powell.

Though unfortunately unable to speak with much experience of the actual working of balloons in action—for I have not been officially employed in this capacity—yet I am frequently asked, having had some practice in military ballooning in times of peace, for my opinions as to its success or otherwise under the conditions of actual hostilities in the Boer War.

South Africa generally happens to be a most unfavourable country for the purpose. First because as a rule it is very open and undulating, so that a general on a hill-top has a wide and extensive view of all around, and there is then comparatively little use for an observer perched in mid air. Secondly, the atmospherical conditions are seldom very favourable. The wind is usually strong, has a way of blowing in very evident gusts, and "devils" or whirlwinds are frequent. I remember seeing a balloon, when close to the ground, caught in one of the latter at Modder River. It was only with the greatest difficulty that it could be kept in hand, and had it not been very ably handled would certainly have been torn to shreds. Shortly afterwards, I believe, a balloon was ripped up under similar circumstances.

As regards the tactical employment of the balloons I am inclined to think, from the limited amount I saw of their working, that they were not utilised to their full advantage. Being ignorant of the orders given or the circumstances governing particular cases, I would not wish to imply blame to individuals, but only to criticise the principles. Usually the balloon was very far from the enemy's position. It is easy to realize how dangerous this form of reconnaissance has become with rifles shooting accurately up to a mile and a half. But something must be risked if we are to obtain good results.

I remember at the battle of Magersfontein, my company was lying down in extended order towards the left of our line. We were perfectly safe from musketry fire, as we lay perhaps two miles from the Boer trenches, which were being shelled by some of our guns close by. The enemy's artillery was practically silenced. Presently, on looking round, I descried our balloon away out behind us about two miles off. Then she steadily rose and made several trips to a good height, but what could be seen from that distance? When a large number of our troops were ranged up within 800 yards of the trenches and many more at all points behind them, what useful information could be obtained by means of a balloon four miles off?

Another point worth criticising in this action was the late hour at which the first ascent was made. As the attack was to have commenced (and, in fact, *did* commence) at dawn, one would have thought it would be most important for the balloon to be actually in mid-air at that moment. Then, at least, one important piece of information could have been gained. It may be remembered that the Boer trenches at Magersfontein were on a gently sloping plain at the foot of some abruptly-rising, rocky kopjes. It appeared, from our point of view, that they were directly at the base of the rocks, and our artillery shelled this locality. Afterwards, however, it transpired that these trenches were mostly a hundred yards or more in advance of the kopjes, so that a large number of our shells must have been wasted on the intermediate ground. Now, an aeronaut ascending fairly close to the position could have ascertained this fact at once.

It is, as a rule, not of much use to adversely criticise actions without suggesting remedies for the mistakes made. I therefore throw forward some hints as to methods which might be pursued.

What might prove to be one of the best means of avoiding as far as possible the dangers of hostile fire would be to make *shorter* ascents. Having carefully decided, while on the ground, exactly what points it was desirable to note, the officer could step into the car and the balloon be allowed to rapidly ascend to its full height. As soon as ever the particular observations had been made, the signal should be given and the balloon rapidly hauled to earth again. Such ascents might often be so quickly carried out that no guns would have time to come into action, and the balloon being almost the whole time moving rapidly it would be well nigh impossible to aim.

If the balloon is fairly close to the enemy's position and rises rapidly to a good height it would float at such an elevation that guns could hardly be elevated sufficiently to hit it. "Pom-poms" will, without doubt, form one of the chief enemies of the war balloon, especially if so delicate a fuze can be made as to burst the shell after penetrating one side of

the envelope. That, indeed, would be a terrible affair. But as now made they are incapable of being elevated sufficiently to shoot at a balloon well up.

There is one more matter to call attention to, and that is free ballooning in war. I believe it was never attempted during the campaign, but there were several occasions on which it might have proved of use. Thus, if a balloon had ascended during a favourable wind at Modder River, it should have had but little difficulty in arriving within the precincts of Kimberley, and thus much valuable information obtained of the exact position of the Boers between those places, which information could have been signalled back. I imagine, too, that the Ladysmith balloon could have been the means of obtaining most important details of the Boer positions north of the Tugela, had a free ascent been made during a northerly wind.

Memorandum Concerning the Use of the Captive War Balloon during the Siege of Ladysmith.

By One of the Imperial Light Horse in Ladysmith During the Siege.

The balloon in use at Ladysmith was a captive one, with, I believe, a 1,000-foot cable. For reconnoitring purposes a captive balloon certainly permitted, at Ladysmith, a view of the enemy's laagers and positions behind the heights surrounding the town, a view that would not otherwise have been obtainable.

Should a balloon be used to observe an enemy supposed to be stationary such as a besieging force, it is very important that such observations should be frequent, otherwise serious mistakes may occur, e.g., the observation made by balloon of the enemy's position two days previous to the battle of Lombaard's Kop showed the Boer right to be their weakest point. During the two days previous to the battle, however, the enemy reinforced their right, which, on the day of the fight, was their strongest point.

There seems little doubt that the rotatory motion of even a captive balloon as well as its undulating movements nullify to some extent its use for reconnoitring, as it is almost impossible to get a continued steady view with a glass. Moreover, if the enemy are not moving, it is not easy to determine their force.

What were believed by the balloon section to be two convoys, whose capture was one of, if not the principal cause of the engagement in Long Valley outside Ladysmith, proved afterwards to be only empty waggons.

As regards the danger of a balloon being hit, the Boers made a habit of firing at the balloon at Ladysmith almost exclusively when it was at a short distance from the ground, some 20 to 60 yards elevation on its descent and ascent. It was then more easy to get the range.

At any elevation over 200 yards this seemed impracticable. It is then very difficult to establish the distance of a balloon from a gun, as well as sometimes not easy to obtain the required elevation of the piece.

The balloon at Ladysmith was hit three times, each time near the ground. The Boers too, had the advantage of having the gun they usually used against the balloon posted on Umbulwana, a hill nearly 1,000 feet high.

During the earlier part of the siege, the balloon made ascents almost daily.

After the siege of Ladysmith, Lord Roberts still continued to use balloons when making his main advance on Pretoria.

The Banquet to M. Santos Dumont.

The banquet given in honour of M. Santos Dumont by the Aero-Club of the United Kingdom at the Whitehall Rooms on November 25, may be described as a brilliant success. Major-General Lord Dundonald occupied the chair. Amongst the large and distinguished company present were the Brazilian Minister, Lord Suffield, Colonel Templer, Director of Military Ballooning, the Hon. C. S. Rolls, Mr. R. W. Wallace, K.C., Chairman of the Automobile Club, the Hon. J. S. Montague, M.P., Mr. Eric Stuart Bruce, Honorary Secretary of the Aeronautical Society of Great Britain, Sir C. Champion de Crespigny, Professor John Perry, F.R.S., President of the Institute of Electrical Engineers, Sir J. Crichton Browne, Major F. C. Trollope, Professor D. S. Capper, Sir V. Kennett Barrington, Colonel R. E. B. Crompton, R.E., Sir Norman Lockyer, Signor Cardoso de Oliveira, First Secretary to the Brazilian Legation, Signor

J. C. Rodriguez, M. Chermont, the Brazilian Consul, Mr. F. H. Butler, Mr. E. P. Frost, Mr. Paris Singer, Dr. Boveston Redwood.

Letters of regret at inability to be present were received from Sir W. Crookes, and Sir D. Solomans.

After the loyal toasts the Chairman proposed the toast of "The Republic of the United States of Brazil," and in reply expressed his pleasure in seeing that his distinguished countryman had alighted in this country. The Brazilian guests would always remember it with gratification and pride. Whatever might be the future prospects of aerial navigation, he was confident that the name of M. Santos Dumont would live in its history as the man who had navigated a flying ship and straightened its course against and across the wind. (Cheers.)

Mr. R. W. Wallace, K.C., in proposing "The Naval and Military Forces of the Empire," remarked that ballooning was peculiarly adaptable to military service as a means of observation. He considered that M. Santos Dumont's airship would be of considerable use in war. The time would probably come when we should have not only our Foot Guards and our Horse Guards, but our Aerial Guards as well. (Cheers.)

Sir C. Champion de Crespigny responded for the Navy.

Colonel Templer, who replied on behalf of the Army, remarked that when M. Santos Dumont accomplished his journey round the Eiffel Tower the weather was so unpropitious at Aldershot that it was believed to be impossible for him to do it. What made the feat so remarkable was that M. Santos Dumont actually rounded the Tower with the wind, came up against the wind and got to his point in the time. (Cheers.)

The Chairman in proposing the health of the guest of the evening remarked that they were there that night to celebrate an event in the history of the world. To science there were no geographical boundaries, or differences either of language or of customs. (Hear, hear.) The man who was victorious over natural obstacles was a friend to all humanity, but none the less were they pleased that their illustrious guest belonged to a nation with which the British nation enjoyed intimate and cordial friendship. For the past century aeronautical students had tried to solve the problem of how to steer a balloon against the wind, and a great amount of brain power had been devoted to the question. It had been left to M. Santos Dumont to illustrate by his remarkable and daring feat the solution of the problem. He felt sure that their guest was far too generous a man to disregard the efforts of his predecessors, and that he would give the credit which was due to that far-seeing and illustrious Frenchman, Henri Giffard, who, in 1851, tried to navigate a cigar-shaped balloon by means of a steam engine against the wind. He would also recognise that his success much depended upon the advance in the construction of light and powerful motors.

It was unnecessary to dwell upon the experiments of M. Santos Dumont. Having previously risked his life in experimental machines, having built his five airships, having been suspended from the top of the Trocadero Hotel, nothing daunted, he accepted M. Deutsch's challenge of £4,000 to the aeronaut who could make the journey of four miles from St. Cloud to the Eiffel Tower and back in half an hour. Their guest obtained the prize, passing round the Eiffel Tower at a height of 1,000 feet above the ground and within a radius of 40 yards, and completed the journey within the specified time. He had, with generosity, handed over the money to the poor of Paris and to those who had helped him in constructing his airship. The feat was a milestone on the onward march of the world. They admired the man who accomplished it for his successful scientific endeavour, for his splendid courage; and he would assure him that not only those in that room, but the whole British people earnestly hoped that his future efforts might be crowned with success. When the names of many of those who had occupied prominent positions in the world should have been long relegated to oblivion, there was one name that would, at all events, be remembered, that was that of M. Santos Dumont. (Cheers.)

When M. Santos Dumont rose, the enthusiastic reception accorded to the aeronaut who has "given wings to the petroleum motor," will be long remembered by those who had the privilege to be a guest that evening. In replying, M. Santos Dumont thanked the promoters of the Aero-Club for having kindly conferred on him the title of honorary founder member of the Aero-Club of the United Kingdom. He reminded the company that he was, for the moment, the only member of the Aero-Club. (Laughter.) He hoped, however, that he should not occupy this solitary position for long. The sympathetic reception he had met with in London would encourage him to return

to London in a few months' time, after his aerial voyage from France to Corsica. (Cheers.) He should then be happy to make some trials in a steerable airship above London. (Loud cheers.) In drinking to the health of the Earl of Dundonald, who did them the honour to preside at this inaugural banquet, he drank to the health and prosperity of the members of the Club present, to those who were absent, and also to the great British nation, which, after gaining the empire of the seas, already aspired, thanks to their initiative to the empire of the air. (Loud cheers.)

Mr. C. F. Rolls replied to the toast, proposed by M. Santos Dumont, and said that a common idea was prevalent that the sport of ballooning was attended with great danger; but during the time the Paris Exhibition was open 600 ascents had been made without a single mishap. (Cheers.)

The toasts of "the visitors" was proposed by Major F. C. Trollope and responded to by Sir J. Crichton Browne. The toast of "the Chairman" concluded the proceedings

Meetings of the Permanent International Aëronautical Commission.

TRANSLATED BY H. A. B.

At the meeting, at the Institute, of the 18th of July, the Commission carried by acclamation, Commandant Renard's proposal to forward their congratulations to M. Santos Dumont on his remarkable experiments of the 12th and 13th of July.

The sub-committee of "Asphyxiation by Impure Hydrogen" reported that the experiments on animals at Chalais confirmed the action of impure gas as a cause of paralysis.

The sub-committee of "Aeronauts' Licenses" reported they were concluding the formulation of a scheme which, while respecting the liberty of aeronauts, would liberally safeguard the public.

M. Moureaux, of the Magnetic Staff at Park St. Maur, had laid before the sub-committee of "Balloon Bearings" a method of magnetically locating the balloon up to about 25 kilometres, by measuring, at 30 seconds, the declinations and inclinations. Height does not affect this method of measurement.

M. Le Comte de la Valette's method of geographical determination by a recognition of characteristic figure-types of the country, is to be called "Topomancy;" the figure-types observed and represented in the dictionary will be railways, watercourses, roads and forests in groups as they occur, and for France there will be from 2,000 to 2,500 observations which will furnish a determination or map of locality at about every 10 kilometres. The signs made use of to represent the above figure-types, railways, etc., in these determinations, are few and simple.

At its latest meeting the Permanent International Aeronautical Commission adopted the scheme of regulations sent up to it by its sub-committee of "Aeronauts' Licenses," and it listened to the legal report on these regulations of M. Laurens de la Barre, advising counsel to the sub-committee.

The object of the sub-committee was to induce a number of Governments to uniformly regulate aerial navigation on a basis liberal to aeronautical development. Controversies as to the national or international character of the resolutions have been met by M. Laurens de la Barre by his dividing the resolutions of the sub-committee into two schemes, the one of a proposed *international character* to embody principles, the other of a *national character*, which is offered to other countries as a type of complementary regulations.

The Police and Public Safety Regulations in force in every country have been reserved; in any country in which his license confers it, a licensed aeronaut is to have equal rights with the licensed aeronauts of that country—this is to be a general measure; in conclusion, the obligatory character of a license, for the contracting States, has been defined.

The International Balloon Ascents.

In September, October and November, international balloon ascents took place in Austria, France, Germany, and Russia. The most noteworthy results appear to have been attained at M. Teisserenc de Bort's Observatory, at Trappes, where the highest altitudes were recorded. On September 5th, in a night ascent, a height of 14,178 metres was reached; the temperature on the ground was 5°.6 C, at the extreme height it was —55°.2 C. On October 3rd, in the night ascent, the height was 14,500 metres. The temperature on the

ground, 8°.1 C, at the extreme height —58° C. In the day ascent, the height was 13,150 metres, the temperature on the ground 11°, at the extreme height —53°. On November 7th, in a night ascent, the height was 13,200 metres, the temperature on the ground was 2°.4, at the extreme height —62°. At Berlin, on the same day, an altitude of 12,010 metres was attained. The temperature on the ground was 6°.5, at the extreme height —58°.4. A manned balloon leaving Berlin attained a height of 1,100 metres, and experienced a wind velocity of 80 kilometres an hour.

It is officially announced that the ascents of manned and unmanned balloons will be continued during 1902, the dates proposed being the first Thursday in each month excepting January, when the second Thursday is selected. A meeting of the International Aeronautical Committee will be held next year in Berlin, when questions relative to the ascents will be discussed.

NOTES.

The Aeronautical Exhibits at the Recent Automobile Exhibition in Paris.—At the Automobile Exhibition held at the Grand Palais, in Paris, in December last, there were several aeronautical exhibits evidencing the alliance which is growing up between automobilism and aeronautics. Prominent amongst the objects of aerial interest was M. Deutsch's steerable balloon the "Ville de Paris" in the Grand Nave. A trial of this balloon is promised for next spring. In the Cupula Hall of the Palais, was the car of Colonel Renard's historical balloon. The Aero-Club illustrated by pictures the nature of the attempt to traverse the Mediterranean by Count de la Vaulx, and the crossing of the Alps by Mr. Henry Deutsch. An exhibit of great scientific interest was the barometric, thermometric and hygrometric records of observations made at great altitudes with ballons-sondes by M.M. Besançon and Hermite during the past 10 years. In an article on these historic records by M. Aimé, in the *New York Herald*, he points out that a glance at some of the themometric charts on view was sufficient to produce a cold shiver. The record is held by the ascent of the aerophile on February 18th, 1897, in which the memorable temperature of —66 degrees was registered. Though human aeronauts can never expect to experience the temperatures registered by the recording instruments of the ballons-sondes, as the limit to human endurance to the conditions of rarefaction seems to be some seven miles, yet aeronauts who make high ascents experience sufficiently low temperatures to make the heating apparatus of M. Jacques Balsan very valuable to aeronauts. As M. Aimé points out in this, heat is obtained without fire, and consequently danger by means of this well-known action of water on quick lime. The constant existence of currents in diverse directions at different levels of the atmosphere is manifested by the ascents of the unmanned balloons. In the words of M. Aimé, who has for years pointed the possibilities of aerial navigation by means of diverse currents, "The winds are the moving side walks of the atmosphere, which offer us gratuitously their platforms superposed and crossed ad infinitum. Instead of continually proceeding against the currents of the air, it will be economical and indispensable to take advantage of them as much as possible, according to Bacon's principle. One triumphs over nature only by obeying her laws."

A well-arranged and instructive exhibit was that of the Aeronautic Club, which showed some very striking examples of progress in the accessories of balloons; for instance, there was a primitive car illustrating the condition of balloon industry 10 years ago. Beside this was the modern car containing such luxuries as seats, drapings, and carpets. There was also an exhibition of the instruments of precision which are indispensable to every aeronaut, including a map of the terrestrial region below the balloon on its movable tablet. A glance at this map and at the earth tells the aeronaut the direction of the wind at every instant. Other objects of interest were M. Bordé's statoscope which records the least upward or downward movement of the aerostat, and his aerial field glass which permits balloonists to observe the horizon accurately. Two popular exhibits were:—1. The chronograph used to take the time of the memorable journey of M. Santos Dumont round the Eiffel Tower on October 19th. 2. The compass needle suspended to the car of the Santos Dumont No. 6.

M. Santos Dumont's Plans.—The next item in M. Santos Dumont's programme is a trip to Corsica from Monte Carlo in his new

navigable balloon No. 7. The new airship is 50 yards long, being 10 yards longer than the No. 6. The trials will commence directly the shed which is being constructed for him by the Prince of Monaco on the sea shore is completed. The gates of this shed are 50 feet in height, and the trees on the boulevard in front have been removed to allow of free exit for the balloon. The hydrogen plant has been installed. When fully equipped the No. 7 balloon will eventually have two motors, fore and aft, of 45-horse power each. During the first few weeks of his stay in the south, M. Santos Dumont will make several trips over the Bay of Monaco in the No. 6 balloon. It is rumoured that at first, with the No. 7 balloon, the old motor of 20-horse power will be used. The advantage of using the lighter motor with the new and larger balloon is that it could carry an ampler quantity of petroleum. The 20-horse power motor would propel the airship at a fair speed. The weight of the 45-horse power motor already built is 175 kilogrammes. It is, however, to be hoped that M. Santos Dumont will, at an early date, avail himself of the greater horse power so that he may be able to combat higher wind forces than he has hitherto done, and thus show a still more decided advance in navigating a balloon against the wind than has been indicated in his experiments this summer. It is now far more important for the development of aerial navigation to institute a series of quantitative experiments in moderate winds even if only short journeys are involved than to undertake long journeys in calm weather, the possibilities of which will not be doubted after M. Santos Dumont's recent experiments. M. Santos Dumont has promised to return to London after his trip to Corsica, and on his navigable balloon to make a journey round St. Paul's Cathedral, though he somewhat dreads the telegraph wires. Whether or not he actually performs this aerial journey, his second visit to London will be most welcome.

The £40,000 Prize.—The authorities of the St. Louis World's Fair have announced that they have decided to offer to aeronauts next year a prize of £40,000 for the successful working of a steerable balloon. This tempting offer will go far to intensify the aeronautical movement that is ushering in the twentieth century, and the present year should be one of the most intense interest to the aeronautical student. It is to be hoped that some of the airships that are being built in this country will be completed in time to take part in the St. Louis competition.

Aerial Wireless Telephone.—The *Daily Mail* reports that M. Ducretet has invented an apparatus enabling aeronauts to remain in communication in the air. The invention is a wireless telephone which is carried in the balloon and which dispenses with the metallic connection with the earth. M. De Fonvielle has pointed out that if the instrument were fitted to a steerable balloon the scientific communion on the Eiffel Tower would be able to transmit orders to the aeronaut directing him to go east or west, to rise or to descend, at pleasure.

Aerial Currents.—The advantage of selecting favourable aerial currents in balloon voyages was exemplified in one of Mr. Charles Rolls' recent ascents. On September 24th, 1901, he ascended from the Crystal Palace in company with Mr. Frank Butler and Miss Butler in a very gentle breeze. Starting, at 4 p.m., in the direction of London, according to the clouds and smoke, the aeronauts expected to sail into the heart of London, where they would have had to descend owing to their shortness of ballast, and they were just preparing for a chimney-pot descent when they found a contrary current which took them nearly over the Palace again, enabling them to find a small piece of green (called Lee Green), in which they dropped just before dark, having used all their ballast.

The Attempt to Cross the Mediterranean in a Balloon.—Although Count De La Vaux and his companions failed to carry out their project of crossing the Mediterranean in a balloon, the voyage was by no means without interest, having lasted forty-one hours and five minutes, thus beating all records for the length of time in the air. The experiments with regard to the possibility of deviating the course of the balloon were absolutely conclusive, and there is now no doubt that with the Hervé apparatus it is possible to remain in a balloon over the open sea for several days. Count Henri de la Vaux intends to renew the experiments with still more perfect apparatus.

The Scheme for Crossing the Sahara in a Balloon.—Captain Debureau, of the French engineers, has devised a bold scheme for the crossing of the Sahara in a balloon.

He has made a special study of the prevailing wind in that region, and according to his calculations, a balloon starting from the south-west of Tunis might be borne at the rate of 20 kilometres an hour to the south-west of the Sahara in about five days. Captain Debureau proposes to make arrangements for a journey taking 12 days; and as a remedy for the gradual loss of gas during the trip he would use the ordinary guide rope and would carry a reservoir containing 1,200 litres of water which would work automatically. By means of an ingenious contrivance a certain amount of the water accumulated would be let out whenever the balloon approached the ground, and relieved of the weight which had drawn it down, the balloon would ascend, until a further escape of gas again sent it towards the ground.

The Balloon in War.— Mr. Eric Stuart Bruce will read a paper before the Society of Arts on the subject of the Balloon in War on Wednesday, February 19th, 8 p.m. General Sir George Higginson, K.C.B., will take the chair.

Foreign Aëronautical Periodicals.

On this list a selection of some of the most notable articles is given.

L'AÉRONAUTE (Paris).

October, 1901.—Projet d'Aérostat Long-Courrier.

November.—Séance de 24 Octobre, 1901.—Les Expériences de M. Santos Dumont: M. E. Aimé.—Procès-Verbal de l'Assemblée Générale Extraordinaire du 14 Novembre.

December.—Conférence de M. Armengaud sur les Expériences de M. Santos Dumont.

L'AÉROPHILE (Paris).

October, 1901.—Portraits d'Aéronautes Contemporains: Maurice Mallet, Georges Besançon; Une Chaudière à Vapeur d'Ether, Henry de Graffigny; Automobilisme Aérien, A Sallé; Tourisme Aérien, Maurice Farman; Ballon Dirigeable à Corps Rigide, Frédéric L'Hoste.

REVUE AMPÈRE (Paris).

November, 1901.—La Conférence de M. Emmanuel Aimé fait sous la Présidence de M. Santos Dumont.

December.—Santos Dumont à la Conférence Ampère.—La Traversée de la Manche en Ballon.

ILLUSTRIRTE AËRONAUTISCHE MITTHEILINGEN.

Ein Ballonaufstieg bis 10,500 m., von A. Berson und R. Süring.—Die Militärluftschiffahrt in Spanien, von H. W. L. Moedebeck.—Die Zivil— und Strafrechtliche Haftung des Luftschiffers, von Rechtsanwalt Dr. G. Rosenberg.—Magnetische Messungen im Ballon, von Dr. Hermann Ebert.—Beiträge zur Mechanik des Fluges und Schwebenden Falles, von Dr. W. Köppen.

Notable Articles.

1901.

Oct. 3. *New York Herald.*—"Mr. Stone's Screw Aerostal."
4. *New York Herald.*—"Her Kress' Catastrophe."
8. *Globe.*—"The Art of Flying."
14. *Standard.*—"By Balloon to Africa."
19. *The Pilot.*—"The Prospects of Flight."
22. *Times.*—"M. Santos Dumont's Balloon."
22. *Daily Telegraph.*—"A Chat with M. Santos Dumont."
22. *Globe.*—"Soaring Flight."

Nov. 5. *Times.*—"The Deutsch Prize."
9. *The Golden Penny.*—"Navigating the Air."
23. *Navy and Army Illustrated.*—"Italian Military Ballooning."
23. *Daily Graphic.*—"M. Santos Dumont in London."
27. *Pall Mall Gazette.*—"Round about the Great Balloon."
30. *Illustrated Mail.*—"How it Feels to Steer an Air-Ship."

Dec. 4. *The Sketch.*—"Scientific Kite-Flying."
7. *Black and White.*—"Shall We Ever Fly?"
9. *Nature.*—"Scientific Ballooning."
21. *New York Herald.*—"Scientific Aeronautics."

Applications for Patents.

(*Made in October, November, and December.*)

Compiled by Bromhead & Co., 33, Cannon Street, London, E.C.

19,594. October 1. Harry Clarke Calloway. **An Improved Aerial Apparatus.**

19,903. October 5. James Blygh Wayman Maunder and Alexander Schanschieff. **Improvements in Air-Ships.**

19,995. October 7. Eugene Lincoln Swingle. **A New or Improved Aeronautic Apparatus or Machine.**

20,008. October 7. Robert John Baldrey. **Aerial Navigation by Means of Bird Traction.**

20,715. October 16. Louis Fillion. **Manageable Balloons.**

21,099. October 21. Augusto Severo. **Improvements in Balloons or Apparatus for Aerial Navigation.**

21,948. October 31. Joseph Cohen and James Little Blain. **Improvements in Aerostats and Navigable Balloons.**

21,977. October 31. Carl August Richard Geilich. **Improvements Relating to Apparatus for Aerial Navigation.**

22,456. November 7. Anton Wiezera and Lewis Wells. **Improvements in Flying Machines.**

23,566. November 20. Samuel Franklin Cody. **Improvements in Kites and Apparatus for the Same.**

23,730. November 22. Edward Minty and John Donkin. **Improvements in Aerial and other Ships.**

24,571. December 3. Eugene Lincoln Swindle. **A New or Improved Flying Machine.**

25,313. December 11. Pierre Lirelli and Henri Myara. **Improvements in or Relating to Air-Ships.**